

CLAIMS

1. Method for controlling a shift from a first mode to a second mode in a multi-mode, electro-mechanical transmission including an input member and an output member, first and second torque transfer devices, at least one motor, first mode operation characterized by simultaneous first
5 torque transfer device applied and second torque transfer device released, second mode operation characterized by simultaneous first torque transfer device released and second torque transfer device applied, and fixed-ratio operation characterized by simultaneous first and second torque transfer devices applied wherein the transmission input member is mechanically
10 coupled to the transmission output member through a fixed ratio, comprising:
applying an oncoming torque transfer device while controlling slip speed across the oncoming torque transfer device to substantially zero by adjusting motor torque and thereafter releasing an offgoing torque transfer device while controlling slip speed across the offgoing torque transfer device
15 to substantially zero by adjusting motor torque.
2. The method for controlling a shift as claimed in claim 1 wherein controlling slip speed across the oncoming torque transfer device to substantially zero by adjusting motor torque terminates when the oncoming torque transfer device is fully applied.
3. The method for controlling a shift as claimed in claim 1 wherein controlling slip speed across the offgoing torque transfer device to substantially zero by adjusting motor torque terminates when the offgoing torque transfer device is fully released.
4. The method for controlling a shift as claimed in claim 1 wherein controlling slip speed across the oncoming torque transfer device and the offgoing torque transfer device to substantially zero comprises controlling

input member speed to a speed whereat the ratio of input member speed to
 5 output member speed is substantially said fixed ratio.

5. The method for controlling a shift as claimed in claim 1 wherein
 applying the oncoming torque transfer device is initiated when a predicted
 period needed for full torque transfer device engagement is substantially
 equivalent to a predicted period for oncoming torque transfer device slip speed
 5 to reach zero.

6. The method for controlling a shift as claimed in claim 5 wherein
 controlling slip speed across the oncoming torque transfer device to
 substantially zero by adjusting motor torque is initiated subsequent to
 initiation of applying the oncoming torque transfer device.

7. The method for controlling a shift as claimed in claim 6 wherein
 controlling slip speed across the oncoming torque transfer device to
 substantially zero by adjusting motor torque is initiated a predetermined time
 prior to slip speed across the oncoming torque transfer device reaching zero.

8. The method for controlling a shift as claimed in claim 7 wherein
 said predetermined time is a function of output member acceleration.

9. The method for controlling a shift as claimed in claim 5 wherein
 said predicted period needed for full torque transfer device engagement is
 adaptively learned.

10. The method for controlling a shift as claimed in claim 5
 wherein said predicted period for oncoming torque transfer device slip speed
 to reach zero is determined from a trend in transmission speeds during said
 first mode operation.

11. The method for controlling a shift as claimed in claim 1 wherein said first mode of operation is preferred for low speed operation, said second mode of operation is preferred for high speed operation, and said shift is an upshift.

12. The method for controlling a shift as claimed in claim 1 wherein said first mode of operation is preferred for high speed operation, said second mode of operation is preferred for low speed operation, and said shift is a downshift.

13. Shift control for a multi-mode, electro-mechanical transmission including an input member and an output member, first and second torque transfer devices, at least one motor, first mode operation characterized by simultaneous first torque transfer device applied and second torque transfer device released, second mode operation characterized by simultaneous first torque transfer device released and second torque transfer device applied, and fixed-ratio operation characterized by simultaneous first and second torque transfer devices applied wherein the transmission input member is mechanically coupled to the transmission output member through a fixed ratio comprising:

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- a computer based controller for establishing motor torque in accordance with one of a plurality of motor controls including;
 - a mode motor control during which said transmission is operating in one of said first and second modes and motor torque is used to control transmission input member speed to a target determined independent of speed across the torque transfer devices,
 - a shift initiation motor control during which motor torque is used to control speed across an oncoming torque transfer device to substantially zero, and
 - a shift completion motor control during which motor torque is used to control speed across an offgoing torque transfer device to substantially zero.

14. The shift control as claimed in claim 13 further comprising a fixed-ratio motor control during which motor torque is not used in controlling transmission speeds.

15. The shift control as claimed in claim 13 wherein said shift initiation motor control is terminated when said oncoming torque transfer device is fully applied.

16. The shift control as claimed in claim 13 wherein said shift completion motor control is terminated when said offgoing torque transfer device is fully released.

17. The shift control as claimed in claim 13 wherein said shift initiation motor control and shift completion motor control comprise controlling input member speed to a speed whereat the ratio of input member speed to output member speed is substantially said fixed ratio.

18. Method for controlling a shift from a first mode to a second mode in a multi-mode, electro-mechanical transmission including an input member and an output member, first and second torque transfer devices, at least one motor, a first mode characterized by simultaneous first torque transfer device applied and second torque transfer device released, a second mode characterized by simultaneous first torque transfer device released and second torque transfer device applied, a fixed-ratio mode characterized by simultaneous first and second torque transfer devices applied wherein the transmission input member is mechanically coupled to the transmission output member through a fixed ratio comprising:

5 establishing synchronous operation of the transmission by using motor torque to control an oncoming torque transfer device slip to substantially zero;

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- establishing fixed-ratio operation of the transmission by
- 15 transferring torque being carried by said at least one motor during
synchronous operation of the transmission to the oncoming torque transfer
device when the oncoming torque transfer device has established sufficient
capacity to accept said transfer of torque without slipping; and,
- establishing synchronous operation of the transmission by
- 20 transferring torque carried by an offgoing torque transfer device during fixed-
ratio operation of the transmission to said at least one motor.

19. A shift control as claimed in claim 18 wherein prior to
establishing synchronous operation of the transmission, using motor torque to
control transmission input speed to a predetermined input speed target.

20. A shift control as claimed in claim 19 wherein subsequent to
transferring torque carried by an offgoing torque transfer device to said at least
one motor, using motor torque to control transmission input speed to a
predetermined input speed target.